Research Paper Engineering

A Technical Approach for Analysis of Wind Power Project in Sikar District of Rajasthan

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ABSTRACT

Wind power has been used for centuries to sail vessels, pump water, grinding grain. Wind energy avoids the external or social costs associated with conventional resources, namely, the trade deficit from importing foreign oil and other fuels, the health and environment costs of pollution, and the cost of depleted resources. The wind's mechanical energy is usually capture by wind turbines and turned into electricity. Wind turbines basically consist of a set of blades connected to a generator or alternator, either directly or via a gear box, which produce power as it is turned by the spinning blades. It is an attempt to structure a model of electricity generation based on multiple combinations of renewable energy technologies with the application of homer energy software at an identified off-grid village location .This model analyses the techno-economic factors with respect to the cost of energy generation.

KEYWORDS System configuration, Cost of energy, Renewable energy technology

I Introduction

The Project harnesses renewable resources in the region, thereby displacing non-renewable natural resources and ultimately leading to sustainable, economic and environmental development. The project will establish a cluster of sophisticated, Enercon E-40 make, Wind Energy Generators of 0.6 MW (7 Nos.) capacities aggregating to a total installed capacity of 4.2 MW in Harsh Village of Sikar District. The generated electricity is wheeled to the nearest grid sub-station through a 33 kV supply line and fed into the grid after stepping up to 132 kV. The purpose is development, design, engineering, procurement, finance, construction, operation and maintenance of wind power project of 4.2 MW in the Indian state of Rajasthan to provide reliable, renewable power to the Rajasthan state electricity grid. The project considered has used the barren land at harsh village, in Sikar district in the state of Rajasthan. The project is helping in bridging the gap between demand and supply of by using wind as a source of generating electrical energy utility. For Harsh, Sikar, various combinations have been obtained of wind systems with wind turbines, generator, batteries, grid and convertors from the homer Optimization simulation.

II Technical concept of wind energy

In wind energy generation, kinetic energy of wind is converted into mechanical energy and subsequently into electrical energy. Wind blowing at high speeds has a considerable amount of kinetic energy. When this kinetic energy passes through the blades of the wind turbines, it is converted into mechanical energy and rotates the wind blades. When the wind blades rotate, the connected generator also rotates, thereby producing electricity. The technology is a clean technology since there are no GHG emissions associated with the electricity generation.

III Technical details of Project Activity:

The wind farm has been developed under the consultation and technological guidance of Enercon India Private Limited. Enercon wind turbines have three rotor blades, usually made of fibre glass, which rotate around a horizontal hub connected to a generator. They have no gearbox or drive train, making them much quieter than conventional gearbox turbines, because they don't produce the mechanical and tonal noise produced by high-speed drive components. The variable speed mechanism on Enercon machines enables the turbine to optimize the energy extraction, increasing the reliability and efficiency of the turbine. Power is controlled automatically as the wind speed varies, with all moving parts on the machines rotating at the same speed of between 18 and 38 rpm depending on the prevailing wind conditions and turbine model. The turbines automatically stop at very high wind speeds to protect them from damage. Wind sensors are used to constantly monitor the wind direction. The Rotor-Hub is directly connected to the Generator Rotor by the Axle pin thus eliminating the Gear Box and couplings. The speed of the generator Rotor is the speed of the Hub Rotor. Thus it rotates at 40 and 30 times lower speed than the Gear Box type Turbines, hence, very low wear and tear. The Synchronous Generator of Enercon with its electronics provides an excellent operational bandwidth i.e. Voltage 415 ± 20% V Frequency 50 ± 5 Hz.

IV Practical concept of Maintenance aspects

On project site there is a schedule for annual maintenance for the entire machine. There are four types of maintenance and machine has to stop for defined time period for maintenance that is Visual maintenance involves average 3 to 4 hr stop of Wind energy generator, Grease maintenance involves average 3 to 4 hr stop of Wind energy generator, Electrical maintenance involves average 16 to 20 hr stop of Wind energy generator, Mechanical maintenance involves average 16 to 20 hr stop of Wind energy generator .Maintenance comprises not only activities to determine and assess a wind turbines actual state but also those to keep the system's nominal state. Repair work necessary to reconstruct the nominal state are not, however, part of these maintenance instructions.

V Software analysis for cost optimization:

It uses homer 2.81 version software and best configuration is selected using total net present cost as its main selection tool. All the possible wind system configurations are listed in ascending order of their total net present cost. As per the optimization results an optimal combination of renewable energy technology system components are a 4200KW wind, 4200KW DG, and a 400KW grid. The total net present cost, Capital cost and cost of energy for such a wind system are Rs.90, 522,784, Rs.84, 380,000 and Rs.0.308/KWh, respectively.

System architecture

Wind turbine	13 Enercon E40
Generator 1	4,200 KW
Grid	4,000 KW

Cost Summary

Total net present cost	Rs. 90,522,784
Levelized cost of energy	Rs. 0.308/KWh
Operating cost	Rs. 480,530/yr

Electrical

Component	Production (KWh/yr)	Fraction
Wind turbines	17,574,216	61%
Generator 1	11,202,207	39%
Grid purchases	6,257	0%
Total	28,782,680	100%

Figure 1.1: Technical & Cost Detail of the Best Suited Configuration for 4.2 MW Wind Power Plants

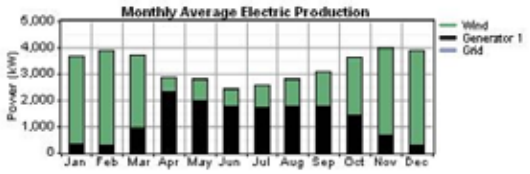


Figure 1.2: Monthly Average Electrical Production from the Considered Renewable Components

Figure 1.2 shows the monthly production of the electricity produced in KW by the Wind and DG. Annualized Costs

Component	Capital (Rs./yr)	Replacement (Rs./yr)	O&M (Rs./yr)	Fuel (Rs./yr)	Salvage (Rs./yr)	Total (Rs./yr)
Enercon E33	6,264,396	0	2,600	0	-592,369	5,674,626
Generator 1	328,552	220,275	2,274	3,462,680	-46,346	3,967,434
Grid	7,823	0	-2,568,584	0	0	-2,560,762
System	6,600,770	220,275	-2,563,710	3,462,680	-638,715	7,081,302

Table 1.3: Annualized Cost of 4.2 MW Wind System

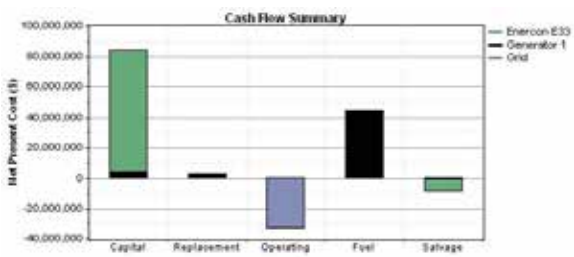


Figure 1.4 Cash Flow Summary based on the Selected Components

Figure 1.4 shows the cash flow summary based on the components selected in the system. The batteries and the converter have a low impact on the capital and Operation & Maintenance costs. Only the generator causes fuel costs. Wind turbine and generator share the maximum portion of the capital investment.

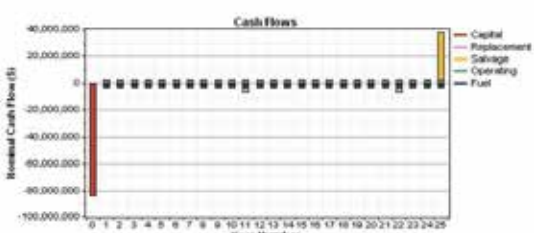


Figure 1.5: Yearly Cash Flow of the System in its Lifetime

The yearly cash flow throughout the system's lifespan is shown in Figure 1.5 Replacements occur majorly in the 11th and 22th year of the system, mostly for changing batteries and maintaining generator. All these cash flow calculations do not consider any discounts, government funding or subsidies.

VI Conclusion and summary:

Off-Grid rural electrification, since the last decade with the help of renewable energy sources (RES) has become a cost-effective and convenient option for areas where grid connection is neither available nor feasible in the near future. Individual analysis of mini wind power is done using software and optimal cost system is designed. As per the optimization results an optimal combination of renewable energy technology system components are a 4200KW wind, 4200KW DG, and a 400KW grid. The total net present cost, Capital cost and cost of energy for such a wind system are Rs.90, 522,784, Rs.84, 380,000 and Rs.0.308/KWh, respectively. The electrification of a location with Renewable Energy Technologies and a diesel backup is both the most cost-efficient and the most environmentally friendly option. In remote villages and in highly populated areas wind energy benefit the environment and village's carbon and other harmful emissions can be reduced up to 90%.

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